CHM2046 Exam 3 Review 7/21/2020 Lead by: Daniel Chong
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1. For a chemical reaction to be spontaneous only at high temperatures, which of the following conditions must be met?

(1) $\Delta S° > 0, \Delta H° < 0$
(2) $\Delta S° < 0, \Delta H° < 0$
(3) $\Delta S° > 0, \Delta H° > 0$
(4) $\Delta S° < 0, \Delta H° > 0$
(5) $\Delta G° = 0$

2. Knowing that $\Delta G°$ of the reaction below is -1351.9 kJ/mol and the following and S° values, calculate the ΔH_f for $CH_3OH(g)$ (ΔH_f of $H_2O(g)$ = -241.8 kJ/mol and ΔH_f of $CO_2(g)$ = -393.5 kJ/mol)

$$2CH_3OH(g) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$$

S° (J/K*mol) | 238.0 205.0 213.7 188.7

(1) -384.4 kJ/mol
(2) -1756 kJ/mol
(3) +192.2 kJ/mol
(4) -192.2 kJ/mol
(5) 0 kJ/mol

3. The K_{sp} of calcium carbonate is 4.7×10^{-9}, what is the $\Delta G°$ of its dissociation in water at standard temperature?
(1) 46.5 kJ/mol
(2) -46.5 kJ/mol
(3) 4751 kJ/mol
(4) -4751 kJ/mol
(5) 2375 kJ/mol

4. In which of the following reactions will the entropy of the system decrease?
I. $N_2(g)$ (@STP) $\rightarrow$ $N_2(s)$ (@STP)
II. Dissolving $O_2(g)$ in water
III. $KF(s) \rightarrow K^+(aq) + F^-(aq)$
IV. $2Fe(s) + 3CO_2(g) \rightarrow Fe_2O_3(s) + 3CO(g)$
(1) Only III (2) I and II (3) III and IV (4) I, II, and IV (5) I, II, and III

5. Which of the following would NOT be true during the reaction $H_2O(l) \leftrightarrow H_2O(g)$ at 373K?
(1) ΔH is positive
(2) ΔS is positive
(3) The average kinetic energy of the molecules stays the same
(4) The internal energy, ΔE, will change
(5) ΔG will be nonzero

6. True or False: During an exothermic reaction, if the ΔS_{sys} increases, then the ΔS_{surr} must always decrease.
(1) True
(2) False

7. Pb(s) has a ΔH_{fus} = 4.64 kJ/mol and a melting point 327.5°C. What is the entropy of fusion (J/K*mol) of 1.0 kg sample?
(1) 2,240
(2) 7.73×10^{-3}
(3) 7.73
(4) -7.73
(5) -2,240

8. The reaction below was found to have a $\Delta G°$ = 2.0 kJ. The equilibrium concentration of B was found to be twice the equilibrium concentration of A. Using this info, what is the $[C]_{eq}$ in M, under standard conditions?

$$A(g) \leftrightarrow B(g) + C(g)$$

(1) 0.446 M
(2) 0.223 M
(3) 0.892 M
(4) 4.484 M
(5) 1.121 M

9. MnO_4^-(aq) reacts with $Fe(OH)_2$(s) in a redox reaction to yield MnO_2(s) and $Fe(OH)_3$(s). Using half-reactions, determine the full net ion equation in **basic** conditions to answer the follow-up questions:

(a) What is getting oxidized?
(b) What is getting reduced?
(c) What is the oxidizing agent?
(d) What is the reducing agent?
(e) How many moles of electrons are transferred?

**More practice for redox balancing:*

Aqua Regia was a solution created from HNO_3 and HCl by Islamic alchemists during 800 AD to dissolve gold. This reaction occurs via a redox reaction and is shown below to create chloroauric acid and nitrite gas. Balance the reaction by the half-reaction method in acidic solution.

$$Au(s) + NO_3^-(aq) + Cl^-(aq) \rightarrow AuCl_4^-(aq) + NO_2(g)$$

(Video of this reaction can be found on the YouTube channel Vsauce:https://www.youtube.com/watch?v=3_7KYoO5qHk)

Answer: $Au(s) + 3NO_3^-(aq) + 4Cl^-(aq) + 6H^+(aq) \rightarrow AuCl_4^-(aq) + 3NO_2(g) + 3H_2O(l)$

10. Consider the following half-reactions:

$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$	E° = +1.23V
$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$	E° = +1.09V
$I_2(s) + 2e^- \rightarrow 2I^-(aq)$	E° = +0.53V
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	E° = +0.34V
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	E° = -0.76V

Which of the following elements or ions can reduce $Fe^{3+}(aq)$ which has a E° = +0.77V

(1) $Br_2(l)$ and $O_2(g)$ (2) $I_2(s)$ and $Cu^{2+}(aq)$ (3) $2I^-(aq)$, Cu(s), and Zn(s)
(4) $I_2(s)$, $Cu^{2+}(aq)$, and $Zn^{2+}(aq)$ (5) $2I^-(aq)$, Cu(s), and $Zn^{2+}(aq)$

11. What were the weakest oxidizing agent and the strongest reducing agent in problem 10?

Weakest OA _________ Strongest RA __________

12. Consider the following half-reactions:

(1) $Hg^{2+}(aq) + 2e^- \rightarrow Hg(l)$	E° = +0.85V
(2) $K^+(aq) + e^- \rightarrow K(s)$	E° = -2.92V
(3) $I_2(s) + 2e^- \rightarrow 2I^-(aq)$	E° = +0.53V
(4) $2H^+(aq) + 2e^- \rightarrow H_2(g)$	E° = +0.00V

Which of the following half-reactions does NOT require an inactive electrode?

13. A voltaic cell is made by immersing a strip of iron metal into a 1.0 M $Fe(NO_3)_2$ solution and a strip of tin metal in 1.0 M $Sn(NO_3)_2$ solution. A wire and salt bridge consisting of the $NaNO_3$ are used to complete the circuit. The concentration of iron ions increases while the concentration of the tin decreases. What is the cell potential and draw a rough sketch of the voltaic cell including electrode charges, the flow of electrons, and the where the ions of the salt bridge are going.

(1) -0.3V (2) 0.3V (3) 0.91V (4) -0.91V (5) 0V

14. True or False: The E_{cell} of a concentration cell is always equal to 0V

(1) True
(2) False

15. What is the pH of the solution at the cathode if E = -0.362V for the following electrochemical cell at 25℃?

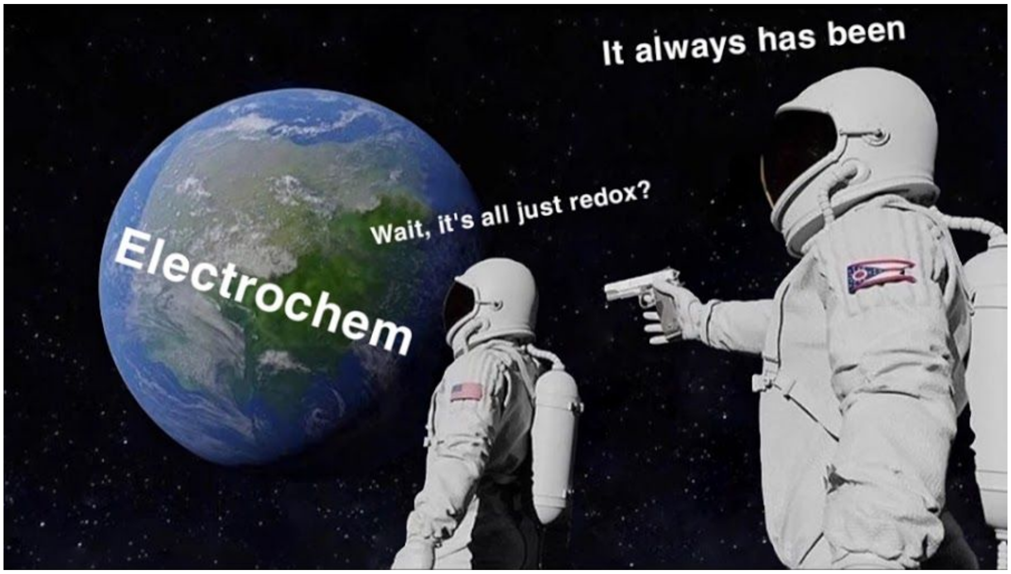
Pt | H_2(g, 1.0 atm) | H^+(aq, 1.00 M) || H^+(aq, ?) | H_2(g, 1.0 atm) | Pt

(1) 1.77 (2) 3.06 (3) 6.11 (4) 7.89 (5) 12.23

16. True or False: Iron corrosion increases when it behaves more like the anode.
(1) True
(2) False

17. A sample of CaCl is mixed with LiBr and melted and put through electrolysis. What are the electrode products at the anode and cathode respectively?
(1) Cl^-(l), Ca^{2+}(l)
(2) (2) Br^-(l), Ca^{2+}(l)
(3) Cl_2(g), Li(l)
(4) Br_2(g), Li(l)
(5) Br_2(g), Li^+(l)

18. What product forms at the anode and cathode respectively in the aqueous electrolysis of NaF with the overcharging of H_2O(l) being +1.4V for oxidation and -1.0V for reduction?
(1) F_2(g); H_2(g) and OH^-(aq)
(2) F_2(g); Na(s)
(3) O_2(g) and H^+(aq); H_2(g) and OH–(aq)
(4) O_2(g) and H^+(aq); Na(s)
(5) F^-(aq); Na^+(aq)



Tips:

- Don't be psyched out by electrochem, I know it's pedantic and stupid but it really is the just the same concept over and over again... REDOX
    - Electrochem all revolves around the exchange of electrons from one thing to another we just label these things with confusing names.
    - Oxidation: the thing is losing electrons (more positive charge)
        - Usually, this is a metal solid because metals have to lose electrons to become positively charged cations
    - Reduction: the thing is gaining electrons (more negative charge)
        - Usually, this is some kind of cation gaining electrons to become a metal solid again. Electrochem is how you can form metal products just from a solution of its ions!
- Anodes are where oxidation occurs which means that in voltaic and electrolytic cells, the ion concentrations will increase because the metal electrode is oxidizing into ion form.
- Cathodes are the opposite of anodes and usually metal accumulates there because ions are reduced to their metal solid state.
- Think of the E° values sort of as a measure of how favorable oxidation or a reduction will occur. All of the leftmost atoms or molecules on the table of reduction potentials on your formula sheet are all oxidizing agents because they all getting reduced. So the more positive (or the higher up in the list) the E° of reaction is, the stronger of an oxidizing agent it is.
- You got this!!! Don't overcomplicate things, if you're stuck always just go back to what you can figure out, "What is being oxidized and what is being reduced?"answering that question can really get you out of a tough spot.